

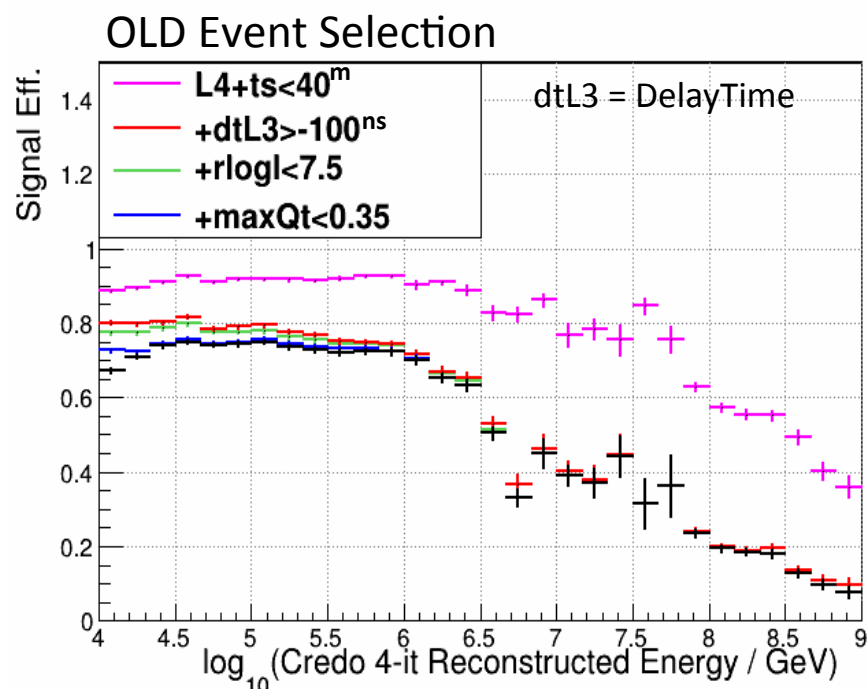
# Rationale for Noise Cleaning of Input Pulses for DelayTime Variable

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# DelayTime Cut Variable

- Before ( $E^{-2}$ ): DelayTime  $> -100$  ns cut (energy independent)
- After plotting signal efficiency using  $E^{-1}$  files (same cut values as for  $E^{-2}$ ), the sudden drop in efficiency at higher energies is clearly visible and it comes from DelayTime cut

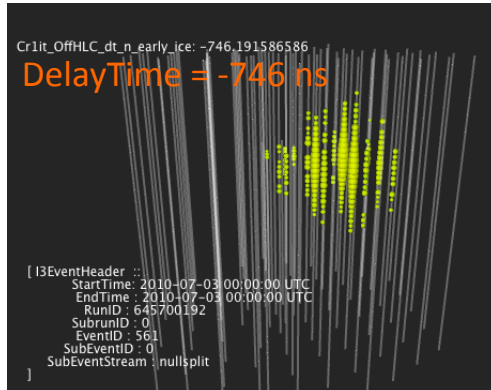


The drop of signal efficiency comes from DelayTime cut

Then, I looked at the signal events removed with DelayTime cut (DelayTime<-100 ns) and found they looked GOOD – no obvious reason why they have so large negative DelayTime value

# Problem with DelayTime Cut Variable

- Example of NuE MC event that survives all the cuts but fails DelayTime > -100 ns (my cut value optimized with E<sup>-2</sup>)



TimeDiff = time of the first hit - vertex time

DelayTime = min(TimeDiff)

PulseMap = OfflinePulsesHLC (w/o saturated DOMs)

Vertex = Credo 1-it

Then, I looked a time difference between all DOMs and vertex time to identify DOMs that give large negative values of DelayTime

Looked at the TimeDiff values for each DOM and time of the first hit t(start) on each DOM

OM(45,13) t(start) = 11387 ns TimeDiff = 663 ns

OM(45,15) t(start) = **9884 ns** TimeDiff = -746 ns

OM(45,15) t(start) = 11929 ns TimeDiff = 1338 ns

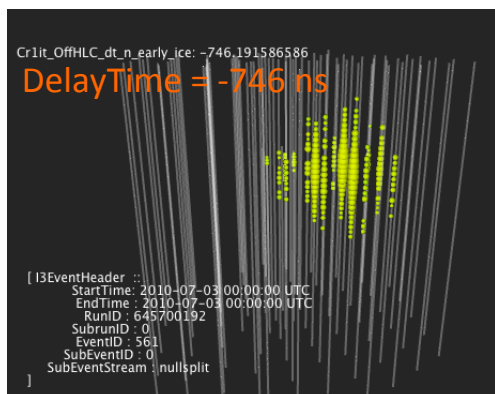


**DelayTime = -746 ns because of the early hit on OM(45,15)**

→ Look at waveforms on the same string

# Problem with DelayTime Cut Variable

- Example of NuE MC event that survives all the cuts but fails  $\text{DelayTime} > -100$  ns (my cut value optimized with  $E^{-2}$ )



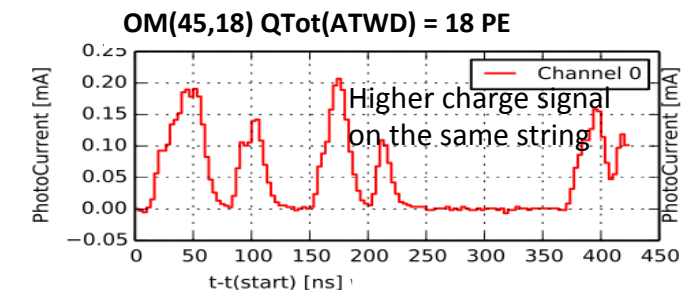
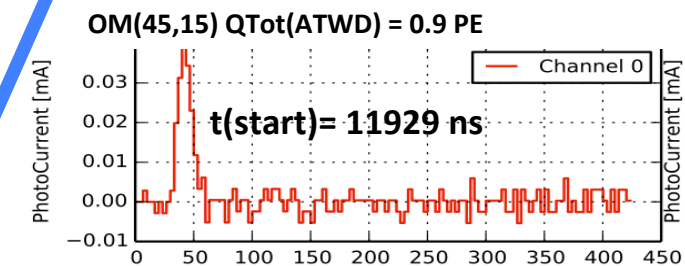
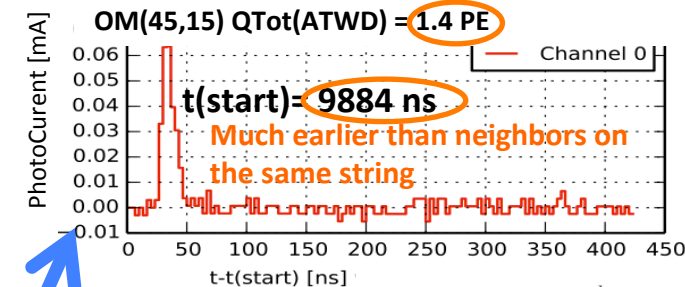
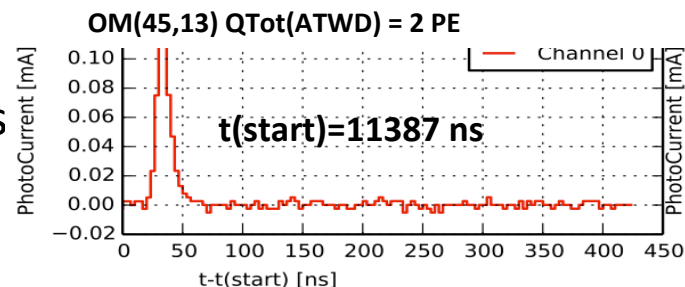
TimeDiff = time of the first hit - vertex time  
 DelayTime = min(TimeDiff)

PulseMap = OfflinePulsesHLC (w/o saturated DOMs)  
 Vertex = Credo 1-it

Looked at the TimeDiff values for each DOM and time of the first hit  $t(\text{start})$  on each DOM

OM(45,13)  $t(\text{start}) = 11387$  ns TimeDiff = 663 ns  
 OM(45,15)  $t(\text{start}) = 9884$  ns TimeDiff = -746 ns  
 OM(45,15)  $t(\text{start}) = 11929$  ns TimeDiff = 1338 ns

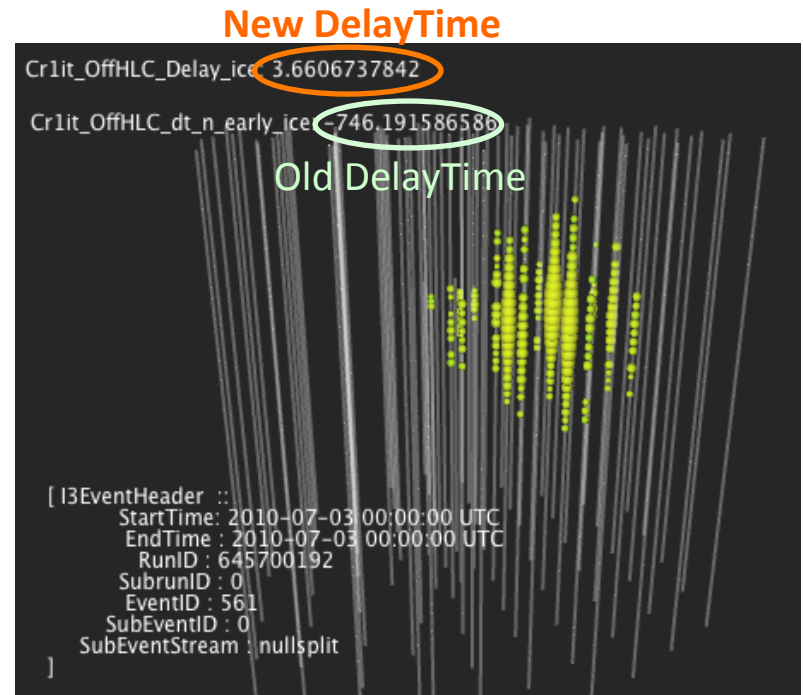
→ **OM(45,15) has an early hit with small charge (<2PE) - needs to be removed from pulse map**



# DelayTime Variable Solution

- I found the following problem:
  - On a string there is an early (much earlier than the neighbors) hit with small charge (of ~few PE) that causes DelayTime to get large negative values (< -100 ns) thus rejects those events
- My solution:
  - clean input pulse series used in DelayTime calculation: for each string remove DOMs with early hits\* and recalculate DelayTime

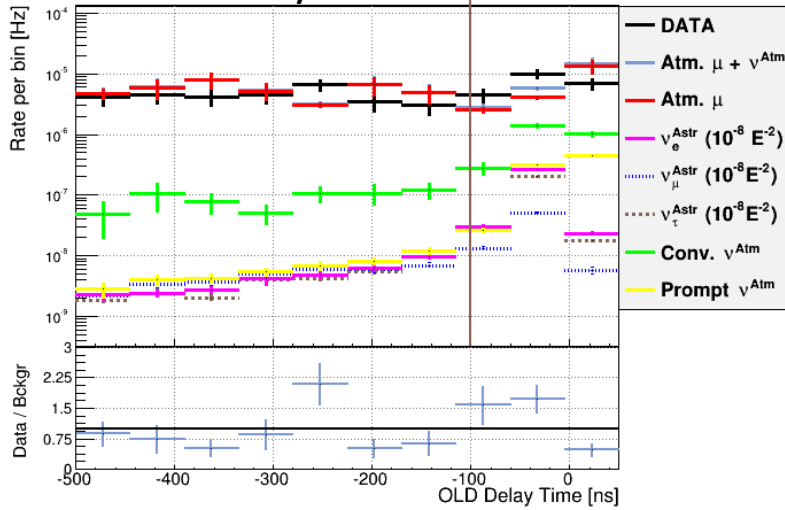
Old and new (recalculated)  
value of DelayTime



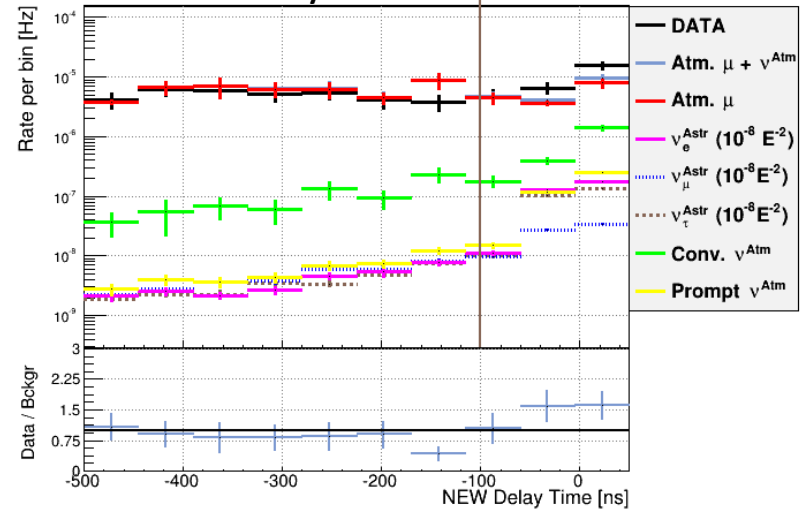
\* Early hit = time difference of the first hit between a given DOM and a neighboring DOM is bigger than 1000 ns and charge is smaller than 2 PE

# Data/MC agreement

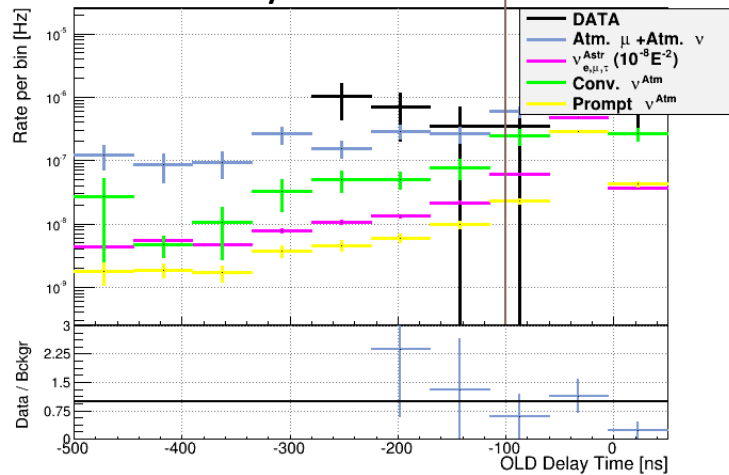
OLD DelayTime after L4



NEW DelayTime after L4



OLD DelayTime after L4A



NEW DelayTime after L4A

